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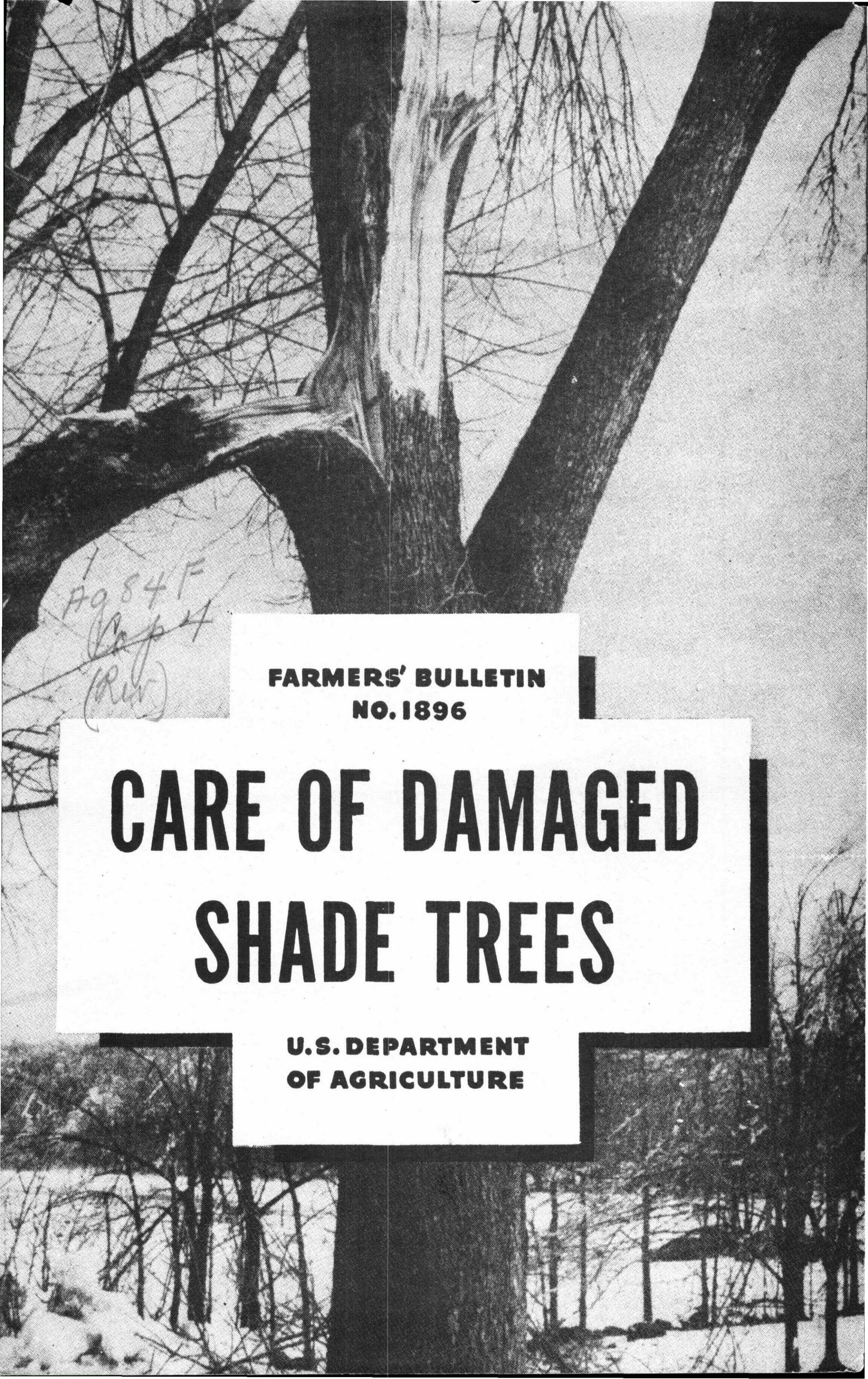

FARMERS' BULLETIN
NO. 1896

CARE OF DAMAGED SHADE TREES

U.S. DEPARTMENT
OF AGRICULTURE

TREES have been a source of many basic life necessities from time immemorial. They have been highly prized for their beauty and their value in providing shade. When trees are so damaged as to no longer be useful, it takes much effort and often many years to replace them. Much damage arises from wounds that can be avoided or can be made less harmful by prompt treatment. Capable commercial tree experts and arborists located in various parts of the country are prepared to render this service. However, the simpler types of treatment described in this bulletin are within the ability of the inexperienced practical man and can be performed with the tools found in the average home. As proficiency is gained, the worker may wish to try some of the more difficult treatments that have been recommended and for which some special tools and hardware are needed.

Two principles that should be borne in mind constantly by owners are (1) that due precautions be observed to avoid wounding of shade trees and (2) that the wounds that cannot be prevented be treated as promptly as possible.

This bulletin supersedes Farmers' Bulletin 1726, Treatment and Care of Tree Wounds.

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CARE OF DAMAGED SHADE TREES [1]

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SCOPE OF THE BULLETIN

WOUNDS, to which the woody parts of trees are constantly subject, are a primary cause of many tree troubles. In vigorously growing trees, most small wounds heal promptly without leading to any important damage. However, in each open wound lies potential disfigurement, impaired health, or untimely death. In many cases the ultimate harmful results that may follow such injuries can be rendered less threatening by prompt treatment after wounding occurs. This bulletin offers some suggestions for the guidance of tree owners who wish to use first-aid methods to minimize wound damage to their shade trees. It is not a manual on methods of repairing trees for the commercial arborist or tree expert, but a primer on tree wounds written for those who are imperfectly acquainted with the subject.

CAUSES OF WOUNDS AND HOW THEY MAY BE AVOIDED

Wounds involving the bark and woody parts of ornamental trees frequently are the result of unfavorable meteorological or biological growing conditions. Most of these causes are so obvious and so well known as to warrant only brief summarizing here. Several of the more important of these causes are described in the following paragraphs, with suggestions for avoiding as far as is possible all unnecessary injuries to woody parts.

INJURIES DUE TO THE WEATHER

Unfavorable weather is one of the chief causes of shade-tree wounds. High winds at any season may break the tops and branches. In

[1] Cooperative investigations carried on by the Bureau of Plant Industry, U. S. Department of Agriculture, and the Osborn Botanical Laboratory, Yale University.

[2] Slight revision by Curtis May, principal pathologist, Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration.

winter, deposits of glaze, sleet, and wet snow may so burden the trees by their weight as to cause failure of limbs, tops, and crotches, and leave in the wake of the storm countless jagged wounds. During the growing season hailstorms may bruise and tear the soft bark of less mature parts, causing myriads of small wounds. Electrical storms record their passing in shattered trunks and ragged streaks, which trace the paths of some of the lightning strokes. Frost cracks and dead areas of inner bark and cambium are common types of wounds resulting from low winter temperatures and early or late frosts and freezes. Sunscald may produce bark wounds regardless of the season. Prolonged drought may kill numerous branches and leave slow-healing branch stubs.

Although it is impossible to prevent adverse weather, much can be done to avert damage caused by it. Judicious pruning to eliminate closely crowded branches and to shorten abnormally long branches, or better still to prevent their formation, does much to avoid breakage by wind and sleet. Bolting and cabling of weak crotches are important. The installation of lightning rods in unusually valuable or priceless historic trees protects them from lightning. Vigorous, well-nourished trees are less subject to winter injury than are weak, starved trees. Marked differences in hardiness occur among various species and varieties of shade trees. Well-planned planting avoids the use of tender southern forms where they will suffer from rigorous winters, or conversely, the planting of northern forms where they will be exposed to very high summer temperatures. If the danger of sunscald is foreseen, the damage may often be averted by wrapping, or even by temporarily shading, the trunks with boards when conditions are particularly trying. Be especially solicitous of trees that are not only subjected to direct sun but are also exposed to its radiated and reflected heat from adjacent walls, sidewalks, and concrete roads. Remember that this type of injury is not restricted to summer. During the winter similar burning is common, especially in the case of evergreens. This usually occurs during periods when the air temperature is fairly high, the sun brilliant, and the ground frozen. Ice and snow often aid in causing the damage by reflecting the light.

Trees suddenly exposed to a marked increase in sunlight are liable to sunscald. If landscaping demands the thinning of natural forest, the work should be extended over a period of years rather than performed in a single release cutting. If a specimen tree requires heavy pruning, it is best to perform the work by degrees rather than as a single operation.

MAN-MADE WOUNDS

Man's lack of understanding of fundamental principles of tree welfare or his indifference in applying what knowledge he has results in much avoidable injury to trees.

Imprudent use of fire wounds many trees. There is little excuse for the careless burning over of land on which ornamentals are planted, for the burning of slash, brush, and litter too close to the tree, or for the too numerous cases where the path of a steam roller through a street is traceable by a wake of scorched limbs and foliage.

Automobiles wound many street trees. Carelessly used lawn mowers bark many trees growing on lawns. The average small boy armed

with a knife or a hand ax causes damage to ornamental trees that grow in more secluded places. Some contractors work havoc with steam shovels, grading tools, and blasting materials, producing untold wounds of trunk, branch, and root. The installation of curbing and of sewer, water, and gas lines is frequently very damaging to street trees.

Ironical though it may seem, many of the injuries that man inflicts on trees are brought about by his misguided efforts in their behalf. Careless pruning provides many such examples. Lopping off enormous limbs unnecessarily often spoils the symmetry of a tree and leaves large exposed wounds. Badly filled cavities furnish another such menace. Careless application of routine tasks of guying and cabling without an understanding of the basic principles involved may cause choking or girdling. Tree bands not applied according to the recommendations of the entomologists are also a frequent cause of severe wounds. The application of cup grease directly to the bark in the hope of protecting the tree from insects is especially to be avoided. The burning out of caterpillar nests is another practice in which the control obtained is frequently not warranted when weighed against the injury done by scorching the bark.

ANIMAL-CAUSED WOUNDS

Animals also cause tree wounds. The gnawing of bark by hungry or impatient horses hitched within reach of trees was in the past one of the chief sources of damage to street trees. Tree guards generally furnish a simple and effective means of protection against such injury. Mice and rabbits frequently injure shade trees. Sapsuckers and other woodpeckers occasionally do damage. Information on the injuries caused by birds and rodents can be obtained from the Fish and Wildlife Service of the United States Department of the Interior, Washington, D. C.

INJURIES INFLICTED BY INSECTS

Insects cause untold damage to trees by direct attack on healthy tissue, by attack following openings or weaknesses induced by some other insects or other causes, or by acting as carriers for disease-producing agencies. Along with a multiplicity of widely varied injuries they produce and enlarge wounds. The Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture and the State entomologist should be consulted in regard to all information relating to damage caused by insects.

INJURIES CAUSED BY PLANTS

Plants as well as animals may cause injury to trees. Among such plants are some of the flowering plants. Parasites such as the mistletoes, common on the shade trees of the South and far West, furnish a classic example of such injury. The American mistletoe can generally be held in check by occasionally breaking it off with a pole. Sometimes climbing vines become so tightly wound about the growing trunks and branches that they strangle them. Either the vines or the strangled parts are as a rule easily removed by judicious pruning. Some tree wounds are self-inflicted or are caused by adjacent trees. Abrasion of branches that rub together when blown by

the wind is a common cause of such wounds. Natural pruning produces numerous wounds. Another type of self-inflicted wound results from girdling roots.

Many kinds of plants that do not produce true flowers or true seeds also occur upon trees. Most of these do not cause wounds. For example, where the air is free from smoke pollution, lichens are found to occur almost universally on trees. Their beautifully varied and fantastic growth is in no wise harmful. Should it be considered objectionable rather than a thing of beauty, control is generally easy to accomplish by an occasional spraying with bordeaux mixture. A similar superficial relationship exists in the case of many forms of fungi that live upon dead parts.

Bordeaux mixture may cause gastronomic disturbances if taken internally, and all unused portions should be disposed of or covered, in order to be inaccessible to children and animals. It is also somewhat irritative to the eyes and skin.

Other forms of fungi and bacteria obtain their nutriment not from the dead parts but from the living parts of the tree. These cause varying degrees of injury that range from scarcely perceptible detriment to injury so marked as to quickly kill large trees. Even among the most parasitic of these fungi, few have the ability to pass through the mature, unbroken, healthy bark and attack the living parts beneath. For the most part the fungi are largely dependent upon entry through breaks in the protective covering such as are afforded by open wounds. Others are able to gain entrance through thinner or less mature protective coverings and working internally kill tissue in such a way as to leave open wounds. The present discussion is not particularly focused upon fungi as a cause of wounds, but rather on the role that they play in interfering with the normal healing of existing wounds, for the fungi probably more than any other single factor cause complications that are generally much more dangerous than are the wounds themselves.

WOUND HEALING

HOW WOUNDS HEAL

Normal healing of wounds is closely related to the growth of woody parts. Increases in the diameter of these parts is brought about, except in the case of such trees as the palm, by growth that takes place directly under the bark. If the growth is not equal for all seasons of the year it is possible to observe how it has taken place by cutting off and examining a small branch. Increases in length are indicated by the spacing between the ringlike scars left by the terminal buds during successive years of growth. Increases in diameter are shown at the cut end of a twig by a series of layers of wood that encircle the pith in concentric rings. Each growth ring usually indicates a year of growth, and is therefore called an annual ring. This is particularly true of northern trees. Commonly in the South and occasionally in the North in certain trees, the resumption of growth following its retardation by severe drought or defoliation may sometimes result in the formation of more than one ring of growth during a given year, but such cases are to be considered as the exception and not the rule.

If, instead of a cross section of a twig, a cross section of a large tree trunk is examined, essentially the same structure as in the twig will

be found (fig. 1). The outer rings of wood are living and are light in color. They comprise the sapwood. Within this circle the wood is generally darker in color and is dead save for the rays that can be seen, especially in oak, to extend as radial lines, part way or entirely, from the pith to the bark. The darkened area comprises the heartwood. It has ceased to function in the growth processes and acts largely to provide mechanical support.

Bark surrounds the wood. It is differentiated into two layers. The outer layer of bark forms a more or less inert, dry, corky protective covering. Within it lies an active, moist layer of inner bark. Between the inner bark and the wood is a very thin and generally

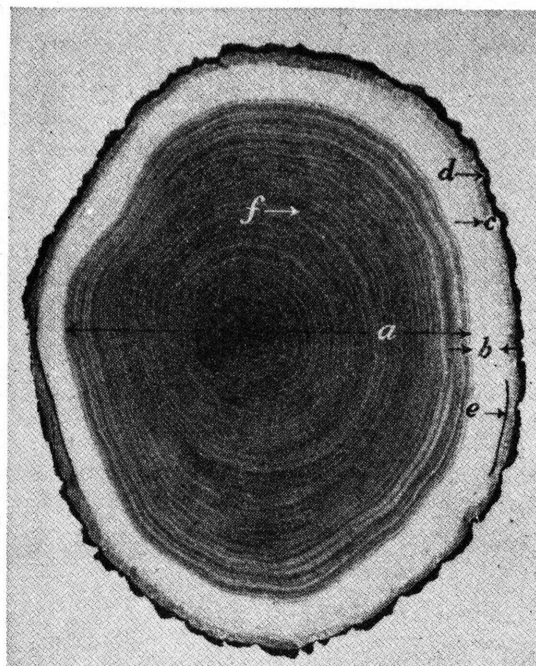

FIGURE 1.—Cross section of a trunk showing: *a*, Heartwood; *b*, sapwood; *c*, inner bark; *d*, outer bark; and *e*, cambium. The concentric growth rings (*f*) are called annual rings. The radial lines are called rays.

inconspicuous layer of cells that comprise the cambium. These cells divide when growth is taking place so as to form bark elements toward the outside and wood elements toward the inside of the layer.

For building material with which to grow in size and number, the living cells are dependent upon a solution of elaborated food that bathes them during the growing season. This food solution moves for the most part downward through the inner bark after being elaborated in the leaves and other green-colored parts of the trees. In order to form this food in the presence of air and light, the leaves require enormous quantities of soil water containing dilute solutions of raw, food-building ingredients. The soil water is mostly transferred upward from the roots to the leaves through the sapwood. Ordinarily growth is most rapid in the spring, slows up as the season progresses, and ceases when the tree is dormant.

Essentially the same growth processes that enable the tree to increase the length or the diameter of its woody parts also function

in healing its wounds. If the end of a branch is broken off, the branch does not necessarily cease to grow in length because it has lost its terminal bud. A shoot from a lateral bud may shortly outgrow its companions and form a new terminal so that the branch continues to grow in length. In like manner growth processes may heal a wound on the trunk or branch. Living cells about the margin of such a wound may form a roll of callus that closes in a little each growing season until the wound is completely covered and healed over (fig. 2)

FIGURE 2.—Healing wounds. *A*, Two wounds that resulted from natural pruning under forest conditions. These wounds have been partially covered by callus. *B*, Three scars left by sawing off branches in the pruning of a shade tree. These wounds have been entirely covered by callus.

Accompanying this healing there are generally internal protective changes that close the vessels in the wood with tiny bladderlike sacs and by the deposition of wound gums.

INCREASING TREE VIGOR AS AN AID TO HEALING

The ability of a tree to callus over wounds is closely correlated with its vigor. Ordinarily a weak or sickly tree will not make marked increases in height and girth, and the owner should not be disappointed with the rate at which wounds heal on such trees. The building-up of the natural vigor of the tree is a very important part of wound treatment, especially if the wounds are large. To a marked degree the success of commercial arborists in treating wounds, especially cavity wounds, is due to the care and skill with which they look to the maintenance of vigor in the trees treated. Too often the home

owner ignores this essential feature and fails to take proper steps to counteract the effect of one of the most common causes of unsatisfactory vigor; viz, soils that do not supply adequate water, air, and food-building materials for normal growth.

Probably the unnatural conditions under which many shade trees are grown are chiefly responsible for unfavorable soil conditions. Too frequently sidewalks, roads, and buildings restrict normal root development, and taste in lawns dictates the maintenance of closely

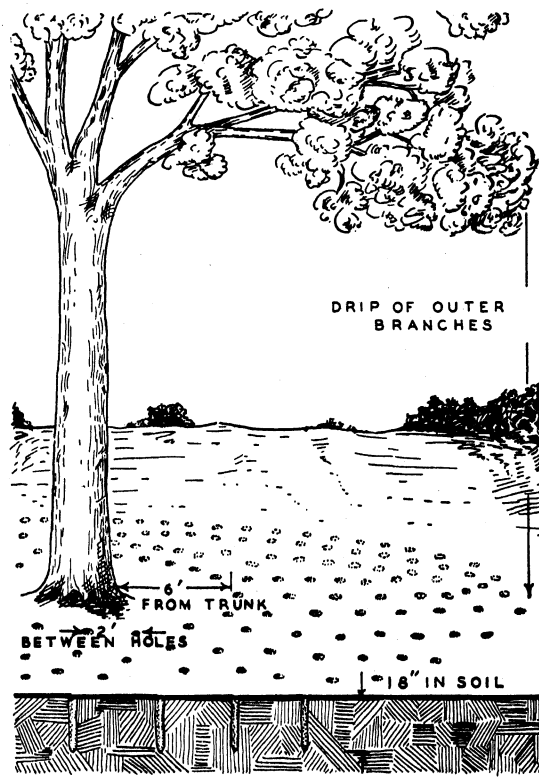

FIGURE 3.—Method of fertilizing a tree by the punch-hole system.

clipped heavy turf from which all leaf litter is raked clean. The natural accumulation of loose duff, similar to that found on the forest floor, is discouraged. The ground becomes abnormally hard and compact. Mineral elements and humus ordinarily supplied by the decomposing leaves are no longer returned to the soil nor are the normal beneficial bacteria and other soil flora and fauna maintained. The air and water-holding properties of the soil are impaired and its nutrient content impoverished. If it is suspected that such conditions prevail and are the cause of unsatisfactory vigor it is often possible to remedy them.

Manure, compost, and peat are substances much used to improve the physical structure of compacted soils so as to make possible normal movement of air and water to the roots. Mechanical loosening is also helpful. Various fertilizing ingredients may be supplied if

deficient. Sometimes these are blown into the soil with compressed air or applied in solution. More usually they are applied in crowbar or auger holes distributed about the base of the tree (fig. 3). The ground in the immediate vicinity of the trunk is left untreated in order to avoid injury. For large trees, these holes should be kept 6 or 8 feet away from the base of the tree; in treating small trees, the holes should be somewhat closer to the trunk. The perforations are usually made to extend out somewhat beyond the drip of the branches. The holes are spaced about 2 feet apart within the area bounded by these two circles. The more numerous the holes, the more even the distribution of the fertilizer. A commonly recommended depth for these holes is 18 inches. If the holes are filled with a material likely to injure sod, it should be poured into the holes through a funnel to within a few inches of the top, and the remaining opening plugged by stamping with the heel or by filling it with loam or compost.

FIGURE 4.—Pruning cuts made on the same day. The bottom cut was made correctly. The branch stub was left too long on one side of the top cut and has interfered with healing.

Authorities differ widely as to the fertilizer dosages and formulas best suited for shade-tree use. For the most part, they are agreed on the advisability of using high-grade complete fertilizers varying in formulas from 6 to 10 percent nitrogen; 3 to 8 percent phosphorus; and 3 to 6 percent potash. The most commonly used rules for de-

termining the quantity to be applied for any given tree call for from 1 to 3 pounds of fertilizer for each inch that the trunk measures in circumference at breast height. The dosage varies with the kind of fertilizer used and with the need of the tree for increased soil fertility. Less fertilizer is generally applied for evergreen than for deciduous trees. Used in these quantities, it is felt by most workers to be safe to fertilize the trees at any season of the year. Spring and fall are considered especially advantageous seasons for fertilizing.

The moisture content of the soil is also an important factor in determining the rate at which wounds will heal. When excess soil water is responsible for poor vigor it is generally possible to remedy the condition by installing suitable drainage. Conversely, where it is possible to apply water generously in times of drought great benefit results. In addition to the soil-improvement treatments already suggested for increasing the water-holding capacity, some watering of ornamental trees is possible. However, the enormous water requirements of large trees make this much less practical for trees than for smaller plants. Surface sprinkling does not suffice. Frequent superficial wetting, if the water penetrates the sod at all, will only serve in time to draw the roots toward the surface and so make the trees more subject to drought injury. The water must soak down deep into the ground, therefore watering should be continued until the ground is spongy under foot.[2]

COMPLICATIONS THAT HINDER HEALING

The healing of a shade-tree wound is often hindered or prevented by complicating factors. For example, the normal healing of a frost crack may be interfered with by its reopening during low temperatures of succeeding winters, or the attack of insects may interfere with its proper healing, or it may become infected with a fungus that causes the wound to enlarge. In this manner complications caused by unfavorable weather, poorly shaped wounds (fig. 4), lack of vigor, injurious insects, and more especially by disease-producing fungi (fig. 5) may slow up or prevent the natural healing processes.

Besides causing wounds, fungi hinder the healing of wounds. They are largely dependent on food developed by other organisms. Fungi that obtain their food from living tissues are called parasites, whereas those that obtain their food from dead organic matter are called saprophytes. In the vegetative stage, fungi are comprised of fine threads called hyphae that grow through the wood or other food medium. Such a mass of vegetative threads is termed a mycelium. The fungi also have a reproductive stage. This has to do with the dissemination and perpetuation of the organism and with carrying it through unfavorable growing conditions. The essential product of reproduction is spores. These are produced in enormous numbers. They are microscopic in size and variable in appearance. They may branch off very simply from the mycelium or be produced in complex-fruiting structures formed by the mycelium. It is these fruiting structures that are generally the most conspicuous and characteristic evidence of the presence of the particular fungi that produce them. They are referred to as mushrooms, toadstools, conks, puffballs, etc.

[2] For a more extended discussion of the importance of the water content of the soil see Farmers' Bulletin 1826, Care of Ornamental Trees and Shrubs.

Spores are distributed by such agents as wind, rain, insects, birds, and other animals. If they reach suitable locations and meet with favorable conditions, particularly an abundance of moisture, the spores may start new colonies of mycelial growth. In this manner many disease-producing fungi are capable of causing widespread infection of trees. Among these fungi are numerous forms that infect open wounds of woody parts. Once established in these wounds, the fungus mycelium may interfere with healing or bring about the decay of the wood. If unchecked by natural causes or by treatment, infection may extend to produce large cankers or extensive areas of decay which ultimately lead to the death or disfigurement of the parts attacked.

When practicable, the removal of fruiting bodies is advised. This will lessen the amount of inoculum released and theoretically, at

FIGURE 5.—The stub of this pruning wound was correctly cut, but the wound dressing with which it was painted was not antiseptic. Fungi have infected the wound and are causing it to increase in size. Antiseptic wound dressings do not always prevent fungus infections of this nature.

least, slow the spread of the spores to other trees. This procedure is to be considered as a precautionary step rather than a treatment of the condition. Since the mycelium permeates the tissue, the removal of the fruiting bodies will not destroy the fungus. To control this type of infection, it is necessary to remove the fungus entirely, to kill it, or to render conditions unfavorable to its further development.

WOUND TREATMENT

PROCEDURE

Excepting seasonal effects, which must sometimes be considered, promptness of treatment is of the utmost importance. All splintered or diseased wood or bark should be removed by clean cuts that conform to the natural lines of sap flow. The tools used for this work

should be sterilized. Unless an antiseptic wound dressing is to be used, the cuts should also be sterilized. All exposed surfaces should be coated with a wound dressing. The completed work should be periodically inspected and any defects repaired.

IMPORTANCE OF PROMPT TREATMENT

Shade trees that perish or are disfigured through neglect not only represent the loss of valuable property, but they are hard to replace. It takes many years to produce sizable specimens of some of the more desirable slow-growing species. The promptness and thoroughness with which treatment is given injured trees have much to do with the results obtained. If wounds are left untreated, or are carelessly treated, disease and decay may become so extensively established as to make repair difficult or impossible. Not only is prevention better than cure; it is usually the only practicable treatment for the inexperienced worker. Most large cavities and decayed limbs could have been prevented by relatively simple shaping and dressing treatments at the time the wounds occurred. It is best to treat wounds before the condition becomes aggravated or complicated.

The average owner can render valuable aid to his trees by simple treatments promptly applied. He may also be able to care for them if delay has allowed the extension of infection to a few sizable branches. When, however, neglect has permitted the infection to go unchecked to the extent that numerous large limbs have died or the trunks have become seriously pocketed with rot, it may be too late to attempt to remedy the condition.

When a tree is very badly decayed, especially if it is of a short-lived, rapid-growing type, or of a species that does not recover well from extensive repairs, it is generally best to consider it a case that is too late for treatment. It is often better to provide for the ultimate replacement of such a tree by planting a vigorous young understudy or to immediately replace it by moving in a sizable tree.

SEASON

Tree repair can be undertaken at almost any time of year when weather conditions permit. In most cases it is best, however, to avoid periods of very active sap flow. These may occur at any time of year, but the most troublesome bleeding is in the spring. The exact time varies for the different tree species. In general it coincides roughly with the time at which the buds expand. Later in the season, when the trees are making rapid growth in diameter, there is a period in which the wood and bark tend to separate. In making repairs at that time, extreme care should be exercised to avoid loosening the bark.

In many cases it is advantageous to make small cuts at a period just prior to sap flow. Such wounds tend to plug and callus quickly after dormancy has broken and thus are not open to possible infection over a prolonged period. Midsummer is an excellent time for pruning out any weak or diseased branches that may have been overlooked in the spring pruning, as such branches are more readily detected by the novice when the trees are in full leaf.

Cavity work and the pruning of large deadwood is probably less favored by the selection of any particular season. Such cuts are too

large to callus over in 1 year, and the wood exposed is usually too mature to produce much natural plugging.

TOOLS AND HARDWARE NEEDED

Much of the wound treatment described in this bulletin can be undertaken with the tools ordinarily found about the average house. Some of the treatments, however, either require special tools or can be performed better and more easily with such equipment.

Unless work is to be done near the ground, ladders and ropes add to the safety of operation. Ordinary ladders are suitable for this purpose. Never use spurs or climbing irons. They injure the trees and spread diseases. If ropes are to be used for climbing or for lowering branches, safety demands that they be reasonably strong. The best grade of long-strand manila rope is well suited to the work. For ordinary purposes a ½-inch rope is used as a hand line and a ¾-inch rope for a lowering line. The usual length for these ropes is 150 feet.

When numerous saw cuts are to be made, the purchase of a pruning saw is usually justifiable because the work can be done more efficiently than with ordinary crosscut saws or ripsaws. A pruning saw about 26 inches long with 5 teeth to the inch is useful for most purposes. Do not use double-edged saws. A pole saw is helpful for pruning limbs that would be difficult to reach without it. Pruning shears, pole pruners, and a large pruning knife are essential pruning equipment. Paint brushes will be needed for dressing the wounds.

The tools thus far described will enable the beginner to perform the work described in this section. For the advanced amateur who wishes to try some of the work described in the sections entitled "Cases Requiring Special Handling" (p. 19) and "Supplementary Preventatives and Repairs" (p. 25), other tools and hardware are listed and described in the following paragraphs.

For shaping wounds and cleaning out cavities, several assorted chisels and gouges are desirable. These should be socket-handled and stout enough to withstand rough use in hardwood. The gouges should be outside ground. One-half inch, ¾ inch, and 1½ inches are desirable sizes for either chisels or gouges. A 2-pound composition mallet is suitable for work with these tools. An oilstone will be required to keep them in condition. Over and above the ordinary sharpness needed for efficiency in cutting, it is essential that these instruments be kept keen-edged to prevent damage to the inner bark and cambium. To maintain this keenness of edge, and even more to protect the worker and the tree, chisels and gouges must be carried in a special tool bag. This consists of a cylinder of heavy leather about a foot long and about 4 inches in diameter, fitted at one end with a wood bottom and at the other with a carrying strap. Under no condition should the worker climb trees or move about in the branches with chisels or gouges carried unprotected in the pockets of his clothing.

For use in bolting, an auger handle and assorted ship augers will be needed. Three of the most used sizes of augers are 9/16, 11/16, and 13/16 inch. A hacksaw, an 18-inch Stillson wrench, and socket wrenches will also be required for bolting operations.

If cabling is to be performed a block and tackle, a pair of pliers with a cutting edge, and a wire stretcher, or come-along, will be useful tools.

In addition to the tools mentioned, certain hardware will be needed for bolting and cabling. Some of this is procurable at ordinary hardware stores, but other supplies must be obtained from marine hardware stores and from dealers who specialize in tree-surgery equipment. When purchasing hardware for tree repair make certain that it has been cadmium-plated, galvanized, copper-covered, or otherwise protected against weathering. The more necessary items will include the following supplies:

Lag-threaded screw rod in ⅝-, ¾-, and ⅞-inch sizes.
Assorted hexagonal nuts and round and diamond-shaped washers to fit the sizes of screw rods listed above.
Lag hooks, right- and left-handed in ⅜-, ½-, and ⅝-inch sizes.
Eyebolts with assorted nuts and washers to fit, in ⅜-, ½-, and ⅝-inch sizes.
Thimbles in 3/16-, ¼-, 5/16-, ½-, and ⅝-inch sizes.
Screw eyes, assorted sizes.
Steel wire No. 10 gage.
Steel cable, 7-wire galvanized or copper-covered strand, in 3/16-, ¼-, and 5/16-inch sizes.

SHAPING THE WOUNDS

The shape of the wound has a marked effect on the rate at which it is possible for healing to take place. Other things being equal, smooth, regular wounds heal more quickly than do rough, irregular wounds. Movement of the elaborated food necessary for the development of the callus is largely downward through the inner bark. Movement in a sidewise direction is restricted. Hence areas cut off from the natural lines of sap flow heal more slowly, or not at all, depending largely on the completeness of their isolation. Jagged extensions of bark at the margin of the wound or protruding branch stubs are often cut off from the food supply. Even if the food substances were available, the callus would not cover such projections as quickly and efficiently as it would cover similar areas of smooth surface.

Wounds should be so shaped, both in outline and in surface, as to conform to natural lines of sap flow. This means that on all sizable cuts it is advisable that the faces be smoothed and the margins of the areas outlining the wounds be streamlined (fig. 6).

REMOVING BRANCHES AND ROOTS

The treatment here described presupposes that the wood where the final cut is made will be sound. If the wood is infected or decayed, the final treatment given should be that described in the section entitled "Cavities" (p. 19).

Final cuts made in the removal of all branches and stubs should leave only smooth-surfaced, streamlined wounds that conform to those described in the preceding section. Prior to making such flush cuts it is frequently necessary to take certain preliminary steps to prevent stripping the bark below the saw cut (fig. 7). This is especially true if the removal of limbs over 5 inches through is involved.

One of the most common ways of avoiding this bark stripping is to remove the limb by two preliminary cuts so as to leave only a short stub for the final cut (fig. 8). The first of these preliminary cuts is made about 10 inches beyond the point where the final cut is to be made. This is done by sawing upward from the lower side of the branch until the saw begins to pinch or until the limb has been sawed about one-third through. The second preliminary cut is then started

from above and about 6 inches beyond the first cut and the sawing continued until the branch splits off. By supporting the weight of small branches with one hand while sawing with the other, it is frequently possible to avoid the necessity for making preliminary saw cuts.

Having made preliminary cuts as described or provided suitable support to prevent the weight of the branch or limb from tearing the bark, proceed with the final cut. This is made by sawing flush with the trunk or limb from which it is pruned (fig. 9). There should be no definite protruding stub left by a correctly made saw cut. On the other hand the worker should avoid carrying the idea of flatness to an

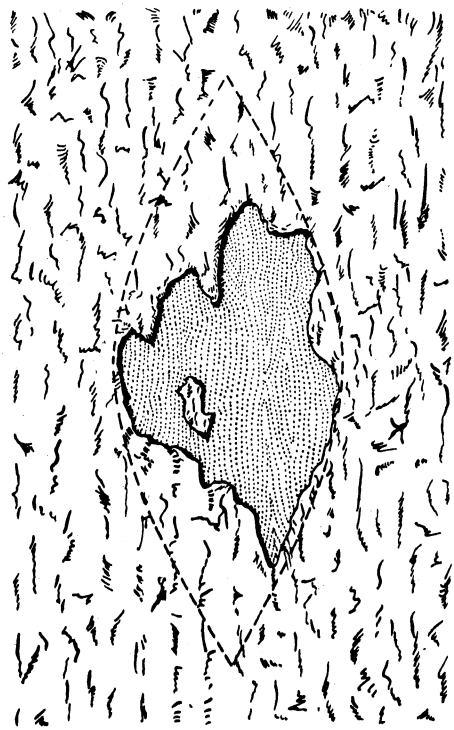

FIGURE 6.—The dotted line indicates the proper shaping for an irregular wound. The bark within the dotted line should be removed.

extreme. To do this increases the size of the resulting wound unnecessarily. With some stubs it is necessary to exercise considerable judgment in order to know just where the final cut should be made in order to assure the most rapid healing. Generally the inexperienced worker errs on the side of leaving too much rather than too little shoulder on the final saw cut. In removing dead branch stubs the wound will heal more quickly if the operator will cut somewhat into the collar of the callus rather than merely sawing off the dead stub.

At times it is not possible to cut to the trunk or a larger branch. This is frequently true in shortening branches and in repairing broken tops. In such cases the cut should be made to a smaller branch or to a vigorous bud. The developing bud and small branch in such cases favor growth to that point and thus aid in healing the wound. If the wood removed is more than an inch or two in diameter it is frequently

advantageous to slant these cuts so that the projecting end of the stub points toward the part selected to act as the sap lifter. It is especially desirable that slanting cuts be used when removing parts that grow upright. Not only does this expedite callus formation, but the resulting wound when surrounded by its ring of callus has less tendency to form a pocket in which water will collect.

Small and inaccessible limbs are often removed with pole saws, the same technique being used as has been described for the final cut with the hand saw. Small branches and twigs are generally removed with pole pruners or hand pruners. If the pruners are of a type that bruise

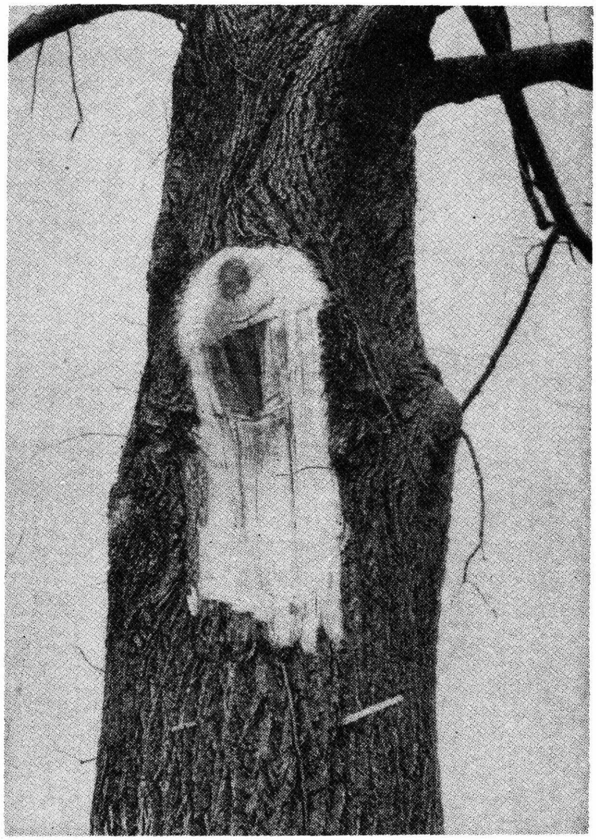

FIGURE 7.—Bark stripping as a result of the improper removal of a large branch by a single cut.

the bark to one side of the cut, care should be exercised to make certain that the bruise is inflicted on the part removed. On very small wood that is within reach an upward cut with a sharp knife gives the best results.

Injured roots sometimes require pruning. In these instances cutting flush to another part is probably less essential than in the cases that have just been considered. The removal of all jagged and irregular exposed wood by clean, sharp cuts and treatment with wound dressing, however, seems just as vital in minimizing infection as it is in the treatment of parts that grow above ground.

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KEEPING THE CUTS STERILE

A 1 to 1,000 solution of bichloride of mercury, or a copper sulfate solution made by dissolving 4 ounces of copper sulfate in 1 gallon of water, are helpful antiseptic washes for sterilizing the surface of wounds prior to the application of dressings. **If bichloride of mercury is used it must be handled with extreme caution. It is deadly poison to man and animals if taken internally and is corrosive to the skin and to metals.** It is best mixed from tablets obtainable at drug stores, each tablet making a pint of solution. Blue or amber glass bottles should be used as containers. These should be clearly labeled as to their content and its poisonous properties. Some workers prefer to dissolve the bichloride in alcohol rather than in water. The alcoholic solution gives improved penetration and quicker drying. If the wound dressing selected for use is not an antiseptic, the use of a sterilizing wash is strongly recommended when diseased wood is cut into. This precaution should be taken to prevent the contamination

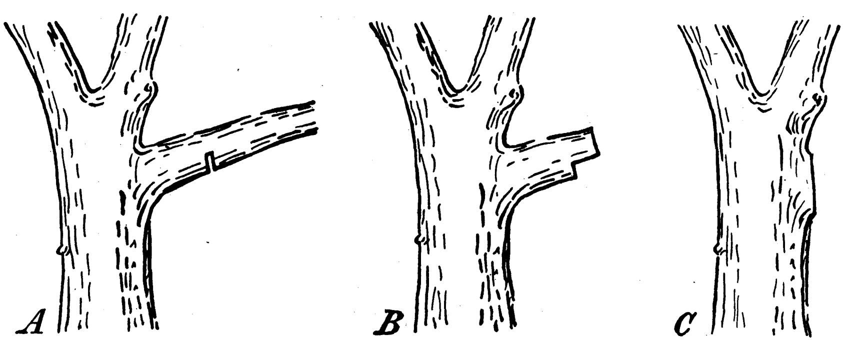

FIGURE 8.—The right way to remove a heavy limb: *A*, First preliminary cut; *B*, second preliminary cut; and *C*, final cut.

of dressings and subsequent spread of the disease. The antiseptic should be permitted to dry before the wound dressing is applied.

The sterilization of tools as well as of wounds is highly important. If due precaution is not observed, pruning and surgery may spread disease rather than retard it. For tool sterilization the writer uses a mixture consisting of 1 part by volume of a 37-percent formaldehyde solution to 9 parts of denatured alcohol. **Since formaldehyde fumes are poisonous due caution should be observed in the mixing and use of the sterilizing solution.** The tools to be sterilized may be swabbed, dipped, or thoroughly sprayed with this solution.

DRESSING THE WOUNDS

It is safest to treat with a wound dressing all shade-tree wounds that expose the wood. Such treatment is less important in the case of small wounds that will heal in one or two growing seasons than for large wounds. It is probably also less important for some conifers that coat their wounds with a resinous exudate than for other trees. A wide variety of materials are used for this purpose. They are applied in the hope of favoring callus growth and of protecting wood that would otherwise be exposed to the ravages of weather and pests during the time required for the new growth to completely close over the wound.

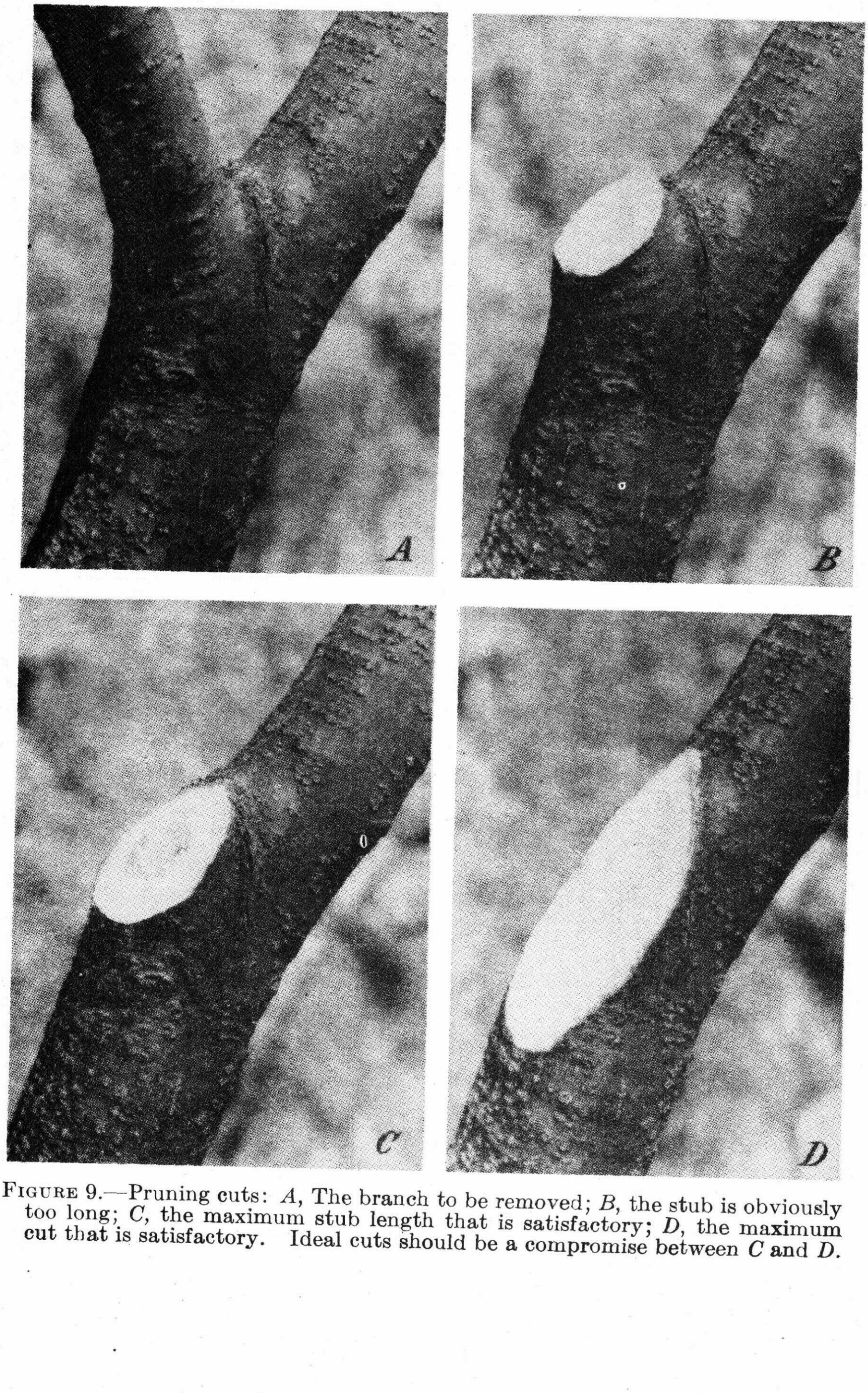

FIGURE 9.—Pruning cuts: *A*, The branch to be removed; *B*, the stub is obviously too long; *C*, the maximum stub length that is satisfactory; *D*, the maximum cut that is satisfactory. Ideal cuts should be a compromise between *C* and *D*.

None of the materials now in use appear to be capable of accomplishing both of these objectives under the various conditions imposed. The ideal wound dressing is yet to be discovered. Climatic conditions, the size of the wound, the species of tree treated, its relative vigor, the particular insects or fungi that it is desired to exclude, as well as many other factors all tend to add to the complexity of the problem and explain why no one wound dressing now in use seems to serve every need. For that reason, it seems advisable to mention several types of dressings.

Creosote and coal tar combinations have long been used and are still popular for dressing tree wounds. The mixtures used are variable. Nor is there uniformity in the unmixed products themselves as sold by various manufacturers. A combination of about one-fourth creosote and three-fourths tar by weight is frequently used. Such mixtures adhere well on freshly made cuts. They are inexpensive. Against these good qualities must be weighed the fact that they frequently become blistered, that they sometimes injure the living parts, and that in many cases they are of questionable antiseptic value. If this type of dressing is used, it is well to be sure that the ingredients selected have been refined by a reliable manufacturer for use in wound dressings. Another safeguard is to avoid contact with the living margin of the wound. This is easily accomplished by leaving the margin untreated when painting the wound with this dressing or by protecting the margin with a coating of shellac before the wound is dressed.

A similar type of dressing that is widely used consists of combinations of creosote and asphalt that are mixed in about the same proportions given for creosote and tar. Asphalt dressings without the addition of creosote are even more popular. Both water emulsions and asphalt cut with various solvents are used. For the most part, the material containing a solvent is mostly used for general work, while the water-emulsion type is valuable for application to wet wood. Generally speaking, the asphalt type of dressing to which no creosote has been added allows the cuts to produce excellent callus. On the other hand, used either alone or mixed with creosote, asphalt applied to wounds that have not been sterilized before they are dressed often fails to prevent infection. Applied in very thick coatings, asphalt not only frequently causes blistering but appears in many cases to stimulate decay rather than to retard it.

Bordeaux paint as developed by S. M. Zeller, of the Oregon Agricultural Experiment Station, is outstanding in its ability to guard wounds from infection and decay, although it will not penetrate bark or wood and destroy fungus mycelium that is already established. The dressing is somewhat pervious and for that reason does not blister or interfere with the natural deposition of wound gums or with tyloses. Bordeaux paint has on the other hand marked disadvantages. It is more expensive than most other dressings. It will not adhere to wet wood. Callus growth under this material is slightly less than that obtained with some of the less pervious dressings. Several investigators have reported an enlargement of wounds following the use of this material. The paint must be freshly mixed. It has an objectionable blue or green color.

Bordeaux paint is made by stirring together raw linseed oil and commercial bordeaux powder to form a thick paint. The bordeaux

powder should be fresh and the paint when mixed used promptly. In mixing the materials, a heavy rather than thin mixture is desirable. When first stirred together, the mixture should be very stiff. After standing a short time, it should be stirred again, and this stirring should produce a heavy, creamlike mixture. If the paint becomes thin on being stirred the second time, thicken it by adding more bordeaux powder. The excess oil in thinly mixed bordeaux paint is harmful to the development of healthy callus growth. Bordeaux paint should be applied heavily to the cut surface, with a swab or a short-bristled brush. **This wound dressing is poisonous if taken internally, and consequently neither the material nor the uncleaned brushes or containers used should be placed within easy reach of children or domestic animals. The vessels containing this and other poisonous preparations should be cleaned immediately after using and any remaining poison disposed of.**

Spar varnish is sometimes used for dressing wounds. It has the advantage of being fairly lasting and of not seriously interfering with callus formation, especially if applied over a coat of shellac. It is not an antiseptic.

Shellac, rubber latex, melted beeswax, and numerous forms of grafting waxes are valuable for treating small wounds. They are also useful for ringing large wounds which are to be treated with a sterilizing agent or a wound dressing that would otherwise be injurious to the cambium.

Antiseptic washes and wound dressings should be applied as promptly as possible. Even a brief delay in their use may permit the entrance of infection. Regardless of the type of dressing used, wounds 2 inches or more in diameter should be examined within 6 to 12 months after the work is completed in order to detect defects and make necessary repairs. Reexaminations are often necessary to protect wounds. Under certain conditions the dressings tend to open with the checking of the wood, or they may blister, peel, or weather away. If they are found to be defective, repair the dressings at once after scraping off any loose or blistered material.

CASES REQUIRING SPECIAL HANDLING

CAVITIES

Thus far discussion has been restricted to the treatment of wounds in which the flush cuts have been made in sound wood. In cases where this final cut exposes diseased rather than sound tissue or where parts have not been removed but decay extends into the trunk or branches, it is usually advisable to remove the infected or decayed tissue before applying dressings or other treatments. The removal of this infected or decayed wood and the subsequent treatment of the resulting wound is referred to as cavity treatment. The dissection of trees shows that a large number of wood decays either do not continue to spread or that they die out naturally when the wound is healed over without any of the decayed material having been removed.

The elementary character of this bulletin makes undesirable the inclusion of any extended discussion of cavity work. The reason for this is obvious. This type of treatment generally constitutes a second line of defense against wood-destroying organisms. The necessity for

resorting to it generally results either from failure to apply first aid promptly or from the ineffectiveness of such treatment.

Before undertaking any repair whatever where cavity work is involved, the novice should be reasonably sure that the work which he proposes to do will be of benefit to the tree. He must realize that unnecessary work or work improperly done may endanger the life or beauty of the tree rather than prove beneficial to it. None but skilled workers should attempt any major cavity treatment. The novice should confine his cavity work to attempts to prevent the extension of minor pockets of decay. To accomplish this, promptness and thoroughness of treatment are vital.

Regardless of where the decayed or diseased area is located, the essential treatment consists in the removal of the apparently infected wood and the sterilization and dressing of the resulting wound. Theoretically, excavation should be continued until the exposed wood

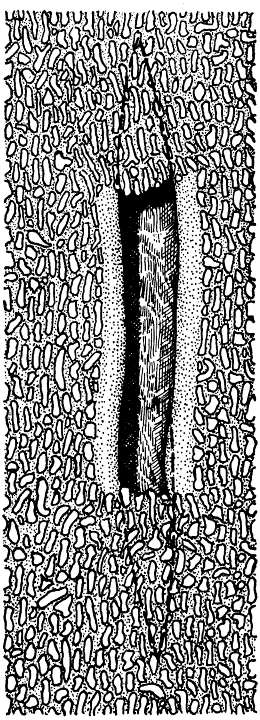

FIGURE 10.—The dotted lines indicate how cavities that have developed lipped rolls of callus should be streamlined.

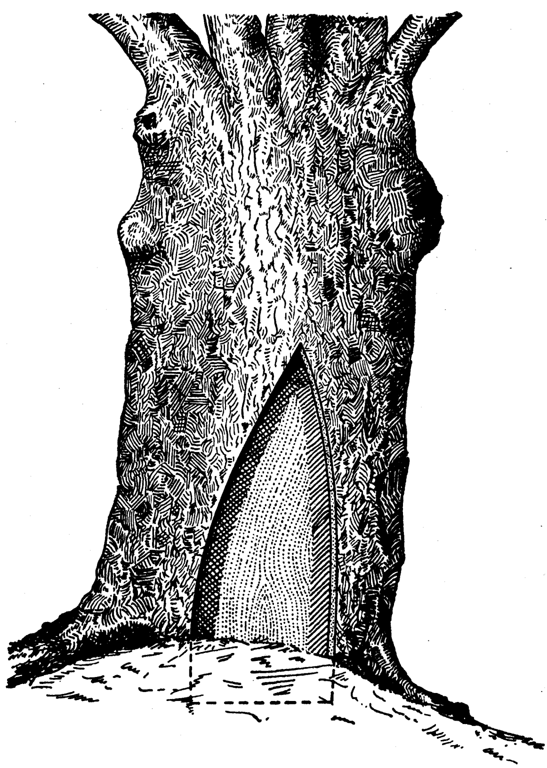

FIGURE 11.—A good type of basal cavity extending well below the ground line.

is sound and entirely free from infection. In actual practice, it is difficult or impossible to determine how far the mycelia of the rot-producing fungi extend into apparently sound tissue. Some fungi extend lengthwise a foot or more beyond visible decay. For this reason, it is generally advisable to remove a certain amount of the

undiscolored wood, if this can be done without structurally weakening the part involved or unduly subjecting it to drying by the removal of all but a shell of sound sapwood. It is often impracticable to remove all of the infected wood.

In excavating, it is desirable that the cavity be kept as narrow as is consistent with suitable cleaning, for increased width much more than increased length retards healing. It is also essential to avoid bruising, springing, or otherwise injuring the bark that surrounds the opening. If the cavity is lipped by rolls of callus, do not cut these unnecessarily for they provide both structural reenforcement and strong lines of sap flow (fig. 10). If the base of the cavity is near the

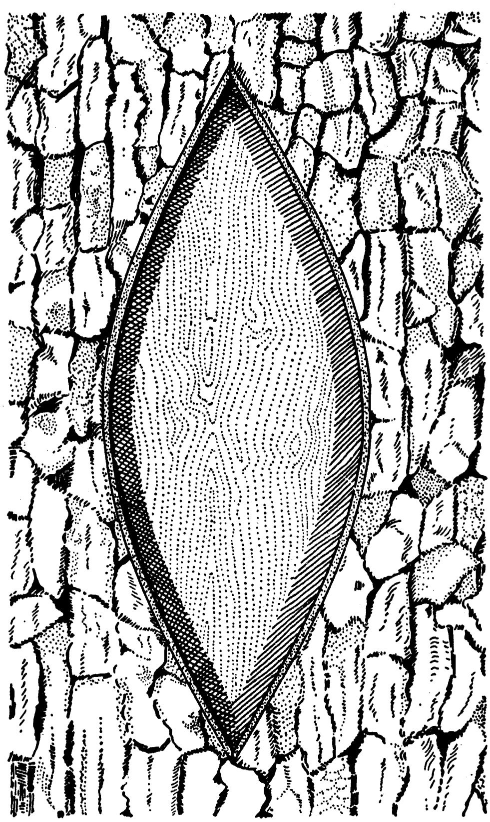

FIGURE 12.—A correctly shaped cavity.

ground, the cavity should be extended well below the surface of the ground (fig. 11).

The final shaping of the cavity is highly important. This must provide for drainage so that water will not be pocketed. It should assure that the outline of the finished cavity be streamlined and have tapering ends (fig. 12). If so shaped, it will best conform to natural lines of sap flow and thus favor rapid marginal healing. The tapering ends should, wherever possible, be carried into areas of strong growth such as are indicated by raised development of the trunk or branch. Depressed bark areas should be avoided, as they are generally areas

of slow growth. All margins should be cut back to live, healthy bark tissues. Places where no live bark comes in contact with the margin should be taken out. The interior of the cavity should be made smooth and free from splintered surfaces. The margins should be cut very carefully with a keen-edged chisel or knife, thin clean cuts being made that will not spring the bark or bruise the living tissue. As soon as these final cuts along the edge of the cavity are made, the margin should be protected from drying out and from the sterilizing agent that will eventually be used. Shellac is excellent for this purpose. It should be applied generously to the narrow strip of exposed cambium and the immediately adjoining bark and sapwood that border it. It is safer to protect a few inches of margin following each final cut, rather than to complete all of the final cutting and then apply the shellac.

When the cavity has been excavated and the margins protected, all exposed wood should be sterilized. An alcoholic solution of mercuric chloride is excellent for this work, but any of the sterilizing agents already suggested may be used. **All mercuric chloride solutions are corrosive to the skin and are deadly poisonous if taken internally. The precautions given regarding the use of ordinary solutions of mercuric chloride apply equally to the mixing and application of alcoholic solutions.** Following sterilization, the wound should be dressed as has already been described for pruning cuts. Here, too, frequent inspection and the renewal of defective dressings are of prime importance.

In commercial practice, it is customary to cross-brace many cavities. No directions for this type of reenforcement are here included because it is the opinion of the writer that ordinarily cavities that involve the removal of sufficient wood to require bracing are better handled by tree experts. Such cases are generally not within the realm of what the average untrained worker is able to do well enough to prove of real benefit to his trees.

Equally questionable in the mind of the writer are the results that the average untrained man will be able to obtain from filling the cavities. The type of treatment just described is known as the open cavity. In the commercial field many cavities are treated as filled cavities. Numerous materials including cement, magnesite, rubber, and wood are used for fillings. The proper application of any of these materials improves the appearance of the tree and supplies a surface over which the new growth can spread. However, in the hands of the uninitiated, cavity filling is often injurious rather than beneficial. For this reason, it is not described in this bulletin.

CANKERS

Although cankers are sometimes confused with mechanical wounds, their treatment is essentially different. It more closely resembles that just described for the open cavity. Even though the exposed wood in the center of the canker seems sound and the roll of callus surrounding it appears superficially healthy, merely painting over the canker will seldom bring about healing. The callus tissue surrounding the dead area at the center of the canker usually harbors the living organism that produced the lesion. Such organisms must ordinarily be killed or removed before the wound will heal normally. Although certain

chemicals either applied superficially or injected are sometimes helpful in arresting the growth of some of the less virulent of these organisms, it is generally quicker and safer for the amateur to cut away the infected tissue. A possible exception to this statement is the small bleeding canker that is said not to be benefited by cutting. The bark at the margin of the canker should then be cut back to clean, live tissue and the wound shaped as for cavity work except that in most cases canker treatment will not involve the removal of more than a few rings of annual wood. When the wound is cleaned out thoroughly and properly streamlined, it should be sterilized and dressed as previously described. The precautions given regarding the sterilization of tools should also be observed.

SUPERFICIAL BARK WOUNDS

Departure from the more routine method of wound treatment is occasionally justifiable in the case of superficial bark wounds that can be treated immediately following injury. A glancing blow from an automobile or lawn mower may tear off a piece of bark in such a way that some of the cambium tissue remains attached to uninjured wood. If this cambium tissue is immediately protected from drying, it will in many cases form a new layer of bark.

In treating such a wound any ragged margins should be traced back smoothly with a sharp knife. Beeswax heated slightly above the melting point is then applied generously to the exposed surface by means of a paint brush. Grafting wax is another excellent dressing for this type of treatment. A thick layer of moist sphagnum moss held in place with burlap has proved beneficial.

Results from this type of treatment are uncertain. Frequently they are very gratifying. Generally the cambium tissue shows remarkable ability to develop rapidly when thus protected from drying. The nature of the injury and the promptness with which treatment is applied are highly important factors in determining the degree of success which may be expected. Success is frequently dependent upon follow-up treatment after the quantity and position of the resurrected cambium tissue are determined.

SAP FLOW FROM INJURIES

Normal sap often flows in quantity from pruning wounds or other types of injuries, particularly those made in late winter or spring. Sometimes the wounds bleed too profusely to permit immediate treatment with wound dressings. Tar compounds or asphalt emulsions are applicable to moist surfaces. Where the flow of sap is too rapid to permit the use of even this type of dressing or where the worker prefers to use some other material less applicable to use on wet wood, it becomes necessary to delay dressing the wound until bleeding has stopped. In such cases it is advisable to sterilize the cut with one of the antiseptic washes already referred to. This should be done both at the time the wound is made and again before applying the final dressing. If the wound is slow in drying up, it is often well to use an antiseptic wash every few days in an attempt to keep the surface as clean and sterile as possible.

SLIME FLUX

Slime flux results from a bacterial infection of the wood. Sour sap exudes from injuries or from pruning wounds and may flow down the trunk over the bark. High pressures are created in the wood of the tree and force out the malodorous fluid. Fluxing is usually most abundant in the spring but sometimes continues throughout the growing season. The exuded fluid frequently thickens until it becomes viscous and sticky. Eventually, if the flux dries, a deposit varying from light gray to brown in color may be left in a more or less vertical streak on the bark over which the flux has run. The clear sap that runs for a short time from fresh wounds should not be confused with slime flux. If injuries do not heal, slime flux may develop later in them. In such cases it is necessary to relieve the pressure before attempting to dry up the wound by surface sterilization. To do this, the water-soaked trunk must be drained by tapping. Generally the region affected extends to the base of the tree. For that reason it is best to first try tapping near the base of the trunk and directly under the part which is fluxing. This may be done by boring a hole to the center of the trunk with a ⅜-inch auger. The hole should be sloped slightly upward to the center of the tree for better drainage. If the waterlogged tissue is tapped, the sour sap should be discharged under pressure. If it is not located by the first drilling, additional holes should be bored higher on the trunk closer to the fluxing wound. When the affected region is located, a short piece of galvanized pipe having a driving fit is forced a couple of inches into the auger hole. The pipe should be long enough to carry the drip free of the trunk and root crown, so that there will be no further killing-back of the bark. If the pressure can be relieved, it is sometimes possible to dry up and treat the wounds, but many cases of slime flux will not respond to this treatment.

The preceding discussion refers to typical slime flux, which should not be confused with the small bleeding cankers occurring on maples and some other hardwood trees in some areas in New England.

GIRDLING ROOTS

Shade and ornamental trees are sometimes subject to girdling by their own roots. This is frequently caused by careless transplanting and may sometimes be aggravated by an excess of organic matter applied near the trunk. When young trees are set out, small roots may get wrapped about the trunk. As both the tree and the roots increase in diameter, the trunk becomes constricted. Natural root grafting tends to prevent injury. At times, however, this grafting takes place so slowly that damage results. If the roots are above the ground, this condition is generally sufficiently obvious to be detected while still in its early stages and the damage prevented by the prompt removal of the girdling root (fig. 13). If the girdling takes place below ground, the trouble is more difficult to detect. It does not generally become obvious to the average tree owner until the tree exhibits symptoms of being poorly buttressed on one or more sides or shows a general weakening of the top. Generally, if the girdling has advanced to this stage, the soil should be pulled back from the root crown and the girdling root removed.

FROST CRACKS

Sudden severe cold frequently splits the trunks of trees (fig. 14). These frost cracks occur longitudinally and are of varying length. They may occur at any point on the trunk but are most common on its south or southwest side. While the temperature is low, the cracks remain open; as the temperature rises, they close. During the growing season these cracks sometimes heal without treatment. In subsequent winters, however, they represent weak points in the trunk that are very apt to reopen. In some trees this repeated opening causes the callus growth on either side of the frost crack to become lipped, and the injury takes on a ridged appearance.

The treatment of frost cracks is not always advisable. Some trees can be helped by treatment. In other cases the trees may reopen

FIGURE 13.—A girdling root.

during sudden extreme cold either along the treated splits or at new places on the trunks.

In many cases, it is best not to attempt treatment if the wound closes tightly during warm weather and appears to be healing without assistance. In other cases where the tree does not appear to be able to heal over the injury, help can sometimes be given by the method described under Lip Bolting. This work should not be performed until the danger of extreme cold is past for the season.

SUPPLEMENTARY PREVENTATIVES AND REPAIRS

LIP BOLTING

Lip bolting is used to close up split trunks or branches. Lag-threaded screw rod obtainable at dealers in tree-surgery supplies (fig. 15) is the most useful hardware for performing this type of

repair. Rods having a diameter of from ⅝ inch to 1 inch should be used, depending upon the size of the tree.

Holes for the insertion of the rod should be drilled $\frac{1}{16}$ inch smaller than the diameter of the rod to be used. They should be spaced 12 to 18 inches apart, depending on the strain anticipated. They should pass almost entirely through the lip that is to be bolted together and roughly at right angles to the split (fig. 16). These holes should be bored alternately from one side and then to the other of the lip. If the holes are slightly staggered rather than exactly parallel, the

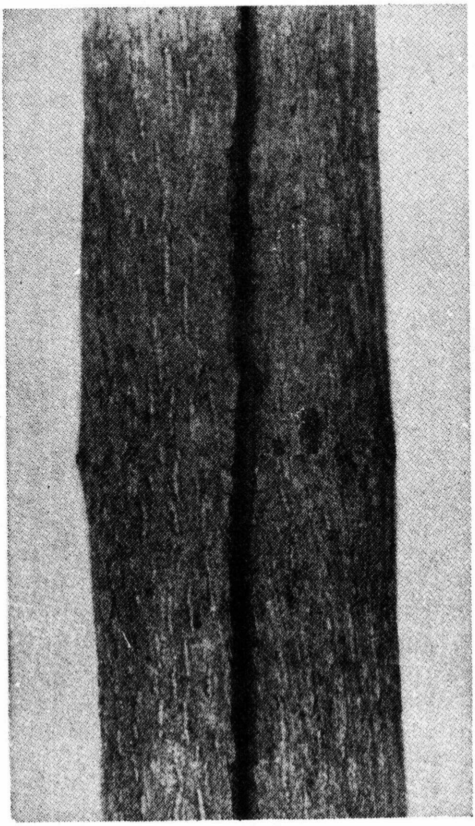

FIGURE 14.—A frost crack.

screw rod will have greater holding power when it is inserted. All holes should be reamed slightly in order to avoid injury to the cambium when the rod is inserted.

Before the rod is inserted the corner of the screw thread should be rounded off at the end of the rod that is to be inserted. Immediately before being inserted the rod should be smeared with asphaltum putty. The rod should then be screwed into place with a stillson wrench. The rod should be gripped with the wrench at a point that will be beyond the bark line when the rod is screwed home. If this is not done the screw thread may be injured. After the rod is inserted, the protruding end should be sawed off flush with the bark of the tree by means of a hacksaw. When the beginner becomes more experienced he can improve this technique by sawing almost

through the rod before it is completely inserted and then breaking it off flush with the sapwood after it has been screwed home.

If the treated tree has very soft wood or if the distance between the center of the crack and the point at which the rod emerges is less than 6 inches, the holding power of the screw thread may not be sufficient. In most cases a minimum grip of about 5 inches of strong wood is required. Therefore the blind-end treatment just recommended should not be used in cases where it is not possible to obtain as much purchase as this, but the screw rod should be put entirely through the tree. If the latter procedure will not provide the minimum grip, washers and nuts countersunk at least ⅛ inch below the cambium and at right angles to the rod may be advisable to reenforce the work (fig. 17). In this case it is advisable to drill the holes the same diameter as the rod in order to permit tightening the crack. Metal-protecting paint should be applied to the exposed metal before the wounds are dressed.

The above treatment presupposes that the crack is tightly closed and sound. If it is decayed or infected, resort to the cavity treatment

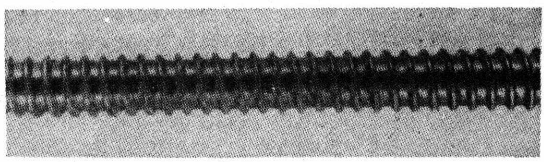

FIGURE 15.—Lag-threaded screw rod.

already described is advisable prior to bolting. Regardless of the condition of the crack, all treatment should include the sterilization and dressing of the wound.

CROTCH BRACING

The same screw rod recommended for lip bolting is an almost invaluable aid for the repair of split crotches or for reenforcing weak crotches to prevent their splitting in high winds or under heavy loads. If the treatment of large trees is anticipated, some 1-inch rod in addition to the ⅝-inch and ¾-inch sizes already suggested will probably be necessary.

Crotch bracing is seldom used alone either for the repair of split crotches or to guard against such damage. It is more often used in conjunction with cabling carried out higher in the tree. Bracing not only strengthens broken or weak crotches; it also gives them a certain degree of rigidity. If not braced, the elements of the crotch tend to sway individually; when correctly braced, they sway as a unit. For this reason crotch bracing is highly important in preventing the reopening of the split while the wound is healing and in guarding against the twisting motion that tends to split weak crotches.

Split crotches should be drawn together before they are braced. A block and tackle used at some height above the crotch is useful for this purpose. When the parts are in place, two parallel holes are drilled through each of the limbs to be braced. As in the preceding method, these holes are made $\frac{1}{16}$-inch smaller in diameter than the screw rod selected for use. The holes will also have to be drilled slightly deeper than the length of the rods to be inserted. This is to make allowance for the sawdust which is pushed ahead of the rod as it is screwed into place. The parallel rods should be installed side by

side (figs. 18 and 19). The distance that these are placed above the crotch varies roughly from several inches in small crotches to several feet in large crotches. The distance between the parallel rods also varies with the size of the limbs to be braced. The larger the branches the farther the parallels are separated. It is generally best to separate them to a distance that approximates one-half the diameter of the branch as measured at the place rodded. Usually the parallels should be from 6 to 12 inches apart. A single rod used alone in the place of the parallels is not recommended, except in the case of small

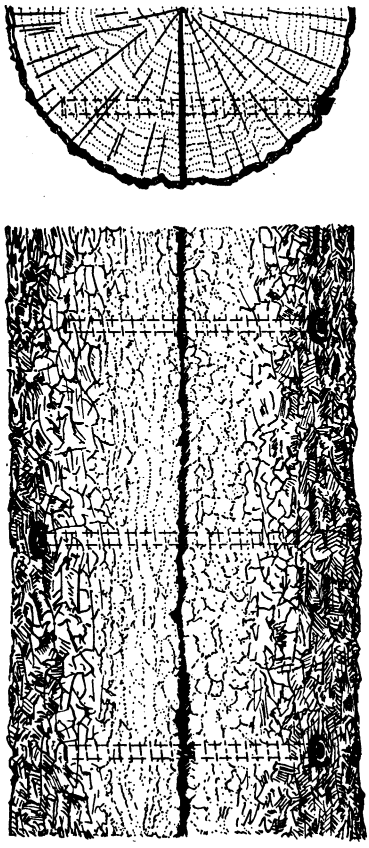

FIGURE 16.—Diagram of the installation of screw rod to repair a split.

crotches, because it is ineffective in overcoming sway. If the split extends any distance into the trunk, the tree should be lip-bolted as described above, the only difference in the procedure being that it will generally be necessary to bolt two sides of the trunk rather than a single side.

All holes should be reamed before the rods are inserted, in order to prevent injuring the bark. Rods above the crotch should be screwed into place with wrenches. The near end of the rod should be cut off with a hacksaw 1 inch before the far end is flush with the bark. Working with the wrenches between the crotch, the rod is then screwed up to advance it a half inch. This procedure will leave both ends of the rod ½ inch below the outer bark.

For trees with soft woods or where undue strain is suspected, the work may be reenforced with washers and nuts countersunk at least ⅛ inch below the cambium. (See also fig. 17.)

CROTCH CABLING

Cabling, either used alone or in conjunction with crotch bracing, is a valuable treatment both to prevent and to repair split crotches. It should be reasonably strong and so installed as to not injure the tree by girdling. A general rule is that the cable should be installed high in the tree. It is usually located at least two-thirds of the way to the top of the branches involved, as measured from the crotch to be protected. Short lengths of cable used low in the tree are to be avoided, as they are subject to failure. Lengths shorter than 2 feet should not be used except in very small trees. Cables should be attached to the limbs by means of screw eyes, lag screws, or eyebolts. They should not be wrapped around the limbs.

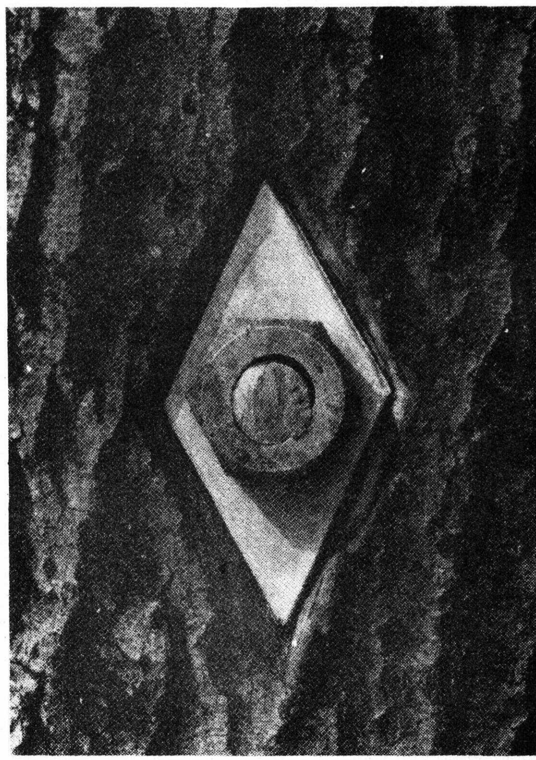

FIGURE 17.—Method of reenforcing with countersunk washer and nut when the holding power of the screw thread is not sufficient.

Where only two branches are involved, a single cable is run between them. Where several branches are involved it is generally advantageous to cable these in triangular or multi-triangular fashion so as to obtain increased leverage against twisting. No specific rule, however, applies to all cases, and the problem of each tree should be carefully considered before the cables are installed.

For treating shrubs and very small trees, screw eyes can be inserted in the branches and the parts pulled together and held in place with

steel wire. Screw eyes in which the ring forming the eye is continuous rather than split should be used. The size of the screw eyes and the gage of the wire can be varied according to the strain anticipated during high winds, or when the branches are laden with ice. Such cabling is very quickly and easily accomplished.

If the trees are sizable, seven-wire strand galvanized or copper-covered steel cable of high tensile strength fastened by lags or bolts will be required. It will frequently be helpful to use a block and tackle or a come-along to pull the limbs into position for cabling. A lag hook (fig. 20) or eyebolt is used for a place of attachment for each cable end, two or more cables not being attached to a single anchor. Lags should not be placed directly below a crotch in the line of inter-

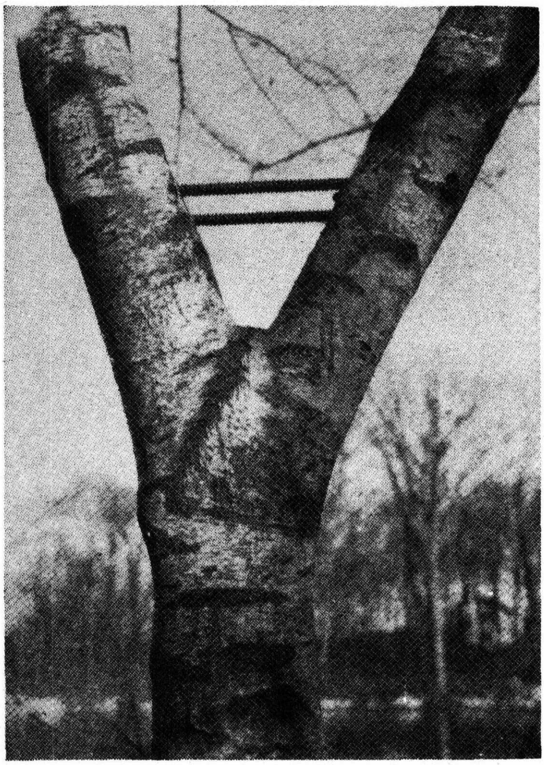

FIGURE 18.—Proper use of two parallel rods to assure the swaying of the crotch elements as a unit.

section or be spaced nearer than a foot apart. Care should be taken to drill holes for them slightly deeper than the lag is to be screwed into the limb. These precautions are to prevent splitting, as it is necessary that the holes in which the lags are to be inserted be made 1/16-inch smaller than the diameter of the lag used. If lag hooks are used, they should be screwed in snugly so that the thimble will not become disengaged (fig. 21). Right- and left-hand lags are used for tightening the cable.

If bolts are to be used, the holes should be drilled the exact size of the bolt in order to insure a tight fit. Asphaltum putty should be coated on the bolt before it is inserted. If these precautions are not observed, decay-producing organisms are more likely to enter the

wound (fig. 22). The washers used on the end of the bolt should be carefully countersunk ⅛-inch below the cambium, care being taken that the washers fit snugly and that they are at right angles to the bolt holes. If diamond-shaped washers are used, they should be installed with the longest dimension parallel to the branch. The nuts

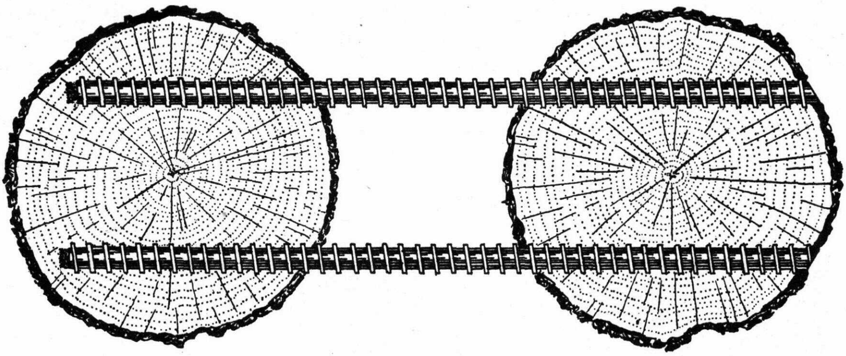

FIGURE 19.—Diagrammatic cross section showing how the parallel screw rods were installed in the tree shown in figure 18.

and washers are treated with a metal-preserving paint and the countersunk area dressed with wound dressing.

For splicing the eyes, the cable is bent double about a foot from the end, a thimble inserted in the resulting loop, and the protruding end

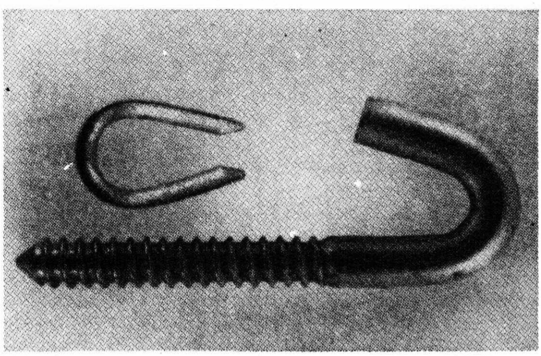

FIGURE 20.—A lag hook and thimble.

of cable unwrapped. With a pair of pliers each of the seven strands is in turn wrapped tightly several times around the cable and the remaining strands and then cut flush (fig. 23). If a lag hook is to be used as an anchor, the completed eye splice can be slipped over the hook. If an eyebolt is to serve as an anchor, the thimble must be inserted in the eye before the cable is spliced. Metal-preserving paint should be applied to the finished splice in order to protect it against breaks in the galvanizing or other protective coating, occasioned by the bending and cutting of the wire during splicing.

The strain to which a cable will be subject is necessarily only roughly related to the diameter of the branch cabled. The angle at which the branch grows, its probable loading with ice, the possible wind velocities

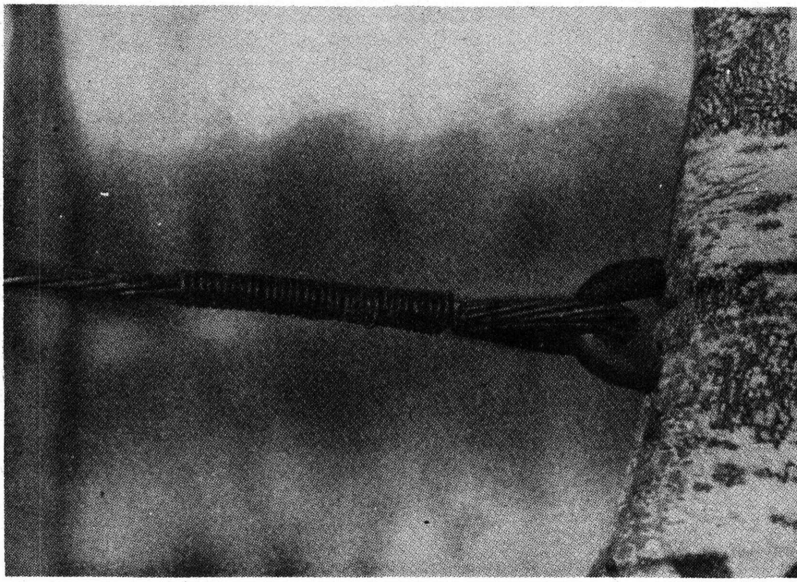

FIGURE 21.—A lag hook that has been screwed in snugly so that the thimble will not become disengaged.

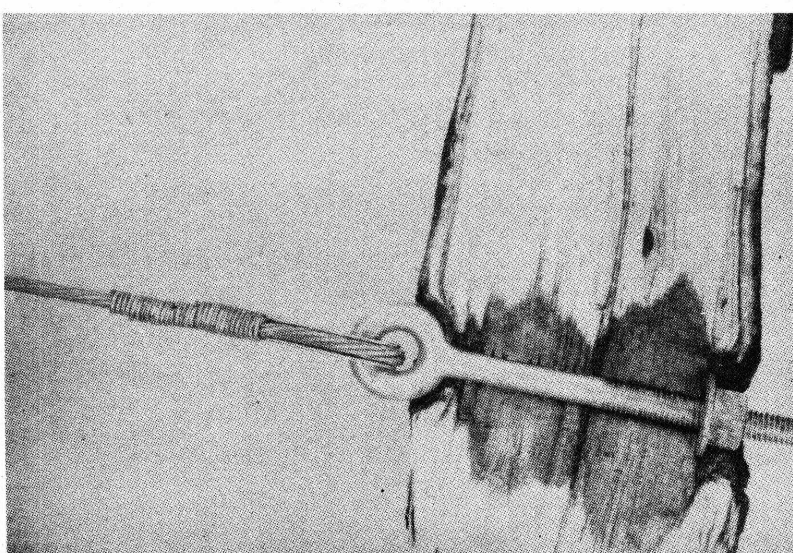

FIGURE 22.—Decay entered this bolt hole, which was not made watertight.

to which it will be subjected, the point of attachment of the cable, and numerous other complicating factors must also be considered. For this reason it is not possible to make more than rough approximations as to the sizes of cable that should be used. Usually, however, a 3/16-inch cable may be used for 4-inch branches, measured at the point of the cable attachment; a 1/4-inch cable for 6-inch branches; and a 5/16-inch cable for 10-inch branches.

It is also impractical to give more specific instructions as to the exact amount of tension that should be used in installing any particular

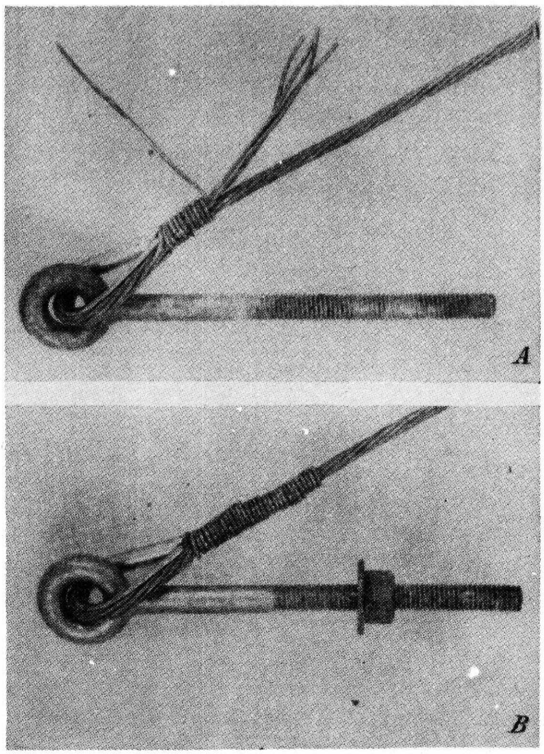

FIGURE 23.—Method of forming an eye splice: *A*, Partially formed splice; *B*, completed splice.

cable other than to state that there should be a continual slight strain on the cable at all times, that is, a cable should not be very taut nor be loose enough to whip. Cables installed in deciduous trees will require more pull if installed during the growing season than if installed during the dormant season. This is to allow for the weight of the foliage, which tends to pull the branches apart.

Like other tree repairs, cable systems require periodic inspection. If weakened by undue strain or rusting, the cable should be replaced.

"POLICING" THE WORK

None of the treatments briefly suggested here, for rendering first aid to wounded trees should be considered complete until the grounds in which the trees are located are cleaned and put in order. Good workmanship in general stresses neatness. In tree surgery, emphasis is placed not on tidy appearance alone but on sanitation. It is with that in mind that the writer has borrowed from the Army the term "policing." "Policing the work" should be considered not only in the sense of cleaning up and putting all in order, but as applying to a protective authority which it is the owner's right to exert in guarding his trees against their enemies. Some pests flourish in dead as well as in living plant material; therefore when all is put in good order after the task is done, no unburned debris should be left to harbor disease or insect enemies.

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